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USE OF EXCAVATING MACHINES IN THE USSR

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The realization of the great program of capital construction approved in the postwar Stalin Five-Year Plan is inseparably linked with the achievement of a vast amount of excavation work calculated in millions of cubic meters. Excavation in construction, due to its scope and costs, occupies an important position in the whole complex of construction work.

In order to build the workshop of a machine-building plant, it is necessary to move 2.5 to 2.6 cu m of earth for every cubic meter of construction volume. In the construction of dwellings, the corresponding volume of excavation and grading is reduced to 0.4-0.5 cu m. In other words, the volume of excavation work comprises from 50 to 250 percent of the construction volume of the building erected.

Even more important is excavation and grading in construction of railroads, automobile roads, and in hydraulic engineering constructions.

History of Excavator Production and Excavation Work

Excavating machines appeared earlier than other construction machines. In Russia, in the middle of the 18th Century, foundation-digging machines were used. In 1909 a Bukhteyev machine, called a shoal-breaker, was working on the Dnepr to clear the sandbanks.

Russia was the first country in Europe to start working with excavators. Four excavators were employed in the construction of the Nikolayev railroad in 1845-1851. At the close of the 19th Century, 15 excavators were in use on

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railway construction work. In 1901, the Putilov plant began making single-shovel excavators mounted on railway trucks, with a dipper capacity of 1.0 and 2.3 cu m, and also built a group of excavators with a chain of buckets for use on the East Amur railway.

At the time of World War I, 1913-1915, there were about 200 excavators in Russia, which permitted a somewhat successful solution of the problem of wartime railway construction.

Excavators were used from 1917 to 1922 in railway construction work, in hydraulic-engineering construction and, to a large degree, contributed to the successful completion of the Volkhov hydroelectric station (1923-1926).

In the construction of the Dneper hydroelectric station, excavators constituted the chief equipment for moving earth, rock, and quarry stones. The extent of mechanization of excavation in this construction was brought up to 85 percent.

During the First Five-Year Plan, simultaneously with the enormous undertaking of industrial construction, the main line of the Turkestan-Siberian Railway, the Canal imeni Moskva, and a series of other huge construction projects were completed.

Maintaining a fleet of excavators could not satisfy the needs of new construction. It was necessary to improve the manufacture of excavators themselves. The first plant which began building excavators was the Kovrov plant which in 1931 constructed single-shovel excavators, mounted on railway trucks, with a dipper capacity of 1.9 to 2.3 cu m. In 1934, this plant began to turn out full-swing caterpillar excavators with 1.5-cu m dippers (PPG-1.5) and, in the last year before the war, it turned out a large number of Diesel excavators with 0.5-cu m dippers (LK-0.5).

At the same time, the construction of excavators was started in a number of other plants (Votkinsk, Kostroma, Kungur, Moscow, Molotov, UZTM, Barrikady, Dmitrovsk, and Kiev). By 1932, 15 single-shovel excavators and 93 excavators with continuous buckets had already been built.

The "Stromstroymashina" Trust was the chief enterprise producing medium- and low-power excavators under the SNK USSR decree of 17 May 1933 and the NKTP Ukaz No 903 of 25 December 1933. To it was entrusted the task of reconverting its plants for the production of domestic machines.

In order to concentrate the hitherto scattered fleet of excavators and in order to secure coordination in their use, in 1934, under the order of the SNK USSR, an All-Union excavator trust, the "Soyuzekskavatsiya," with a network of regional excavator stations, was incorporated in the NKTP and was placed under direct jurisdiction of the "Glavstroyprom." To carry out capital repairs, a series of plants was transferred to the trust. Similar trusts were created in the NKPS, NKVD, and NKZ.

In carrying out Directive No XVII of the 6th VKP Congress on the scope of basic construction work of NKZ mechanization, and extensive plan for turning out excavators was contemplated.

From 1933 to 1936 the Stromstroymashina plants turned out 144 type-MPP single-shovel steam excavators with a capacity of 1.5 cu m, 72 MPP single-shovel steam excavators with a dipper capacity of 0.75 cu m, 96 Type M-L-IV single-shovel excavators with a capacity of 0.35 cu m (equipped with tractor engines), and 167 M-2L trench excavators (trenching plows).

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There was a simultaneous development in the design of Soviet excavators. In 1933, in Leningrad, an excavator-construction group was organized in the Scientific Research Institute for Machine Construction (based on the experience of the Kirov plant) but independent, in the future, of the technical planning office of excavator construction (VTKE). The nomenclature for excavators to be produced in the USSR was worked out in 1932.

The All-Union Technical Office of Excavator Construction designed (for production in the Dmitrovsk plant and the "Red Excavator" Plant) some models of the E-1 trench excavators with continuous buckets (35-liter bucket, depth of excavation about 2.25 meters), the UKP (60-liter bucket, excavation depth 4.0-6 meters), and the MK-IV (8-liter bucket, excavation depth up to 1.2 meters). These excavators had internal-combustion engines and were mainly intended for digging trenches in communal construction.

During the years of the Five-Year Plans up to 1941 several thousand single-shovel and continuous-bucket excavators were built. During this period single-shovel excavators with dipper capacities of 0.35, 0.5, 0.75, 1.1, 1.5, 1.9-2.3, and 3 cu m and continuous bucket excavators for trench depths of 1.2, 2.2, 3.5, and 6 meters were produced. Ladder-type excavators for brickyard pits were also turned out.

The fleet of excavators completed at the beginning of World War II played a very important part in winning the war. The part they played included the construction of railways in the rear and at the front, work in the expansion of ferrometallurgical enterprises, extensive work in building liquid fuel bases, and in enlarging the coal-tar products enterprises in the East. At construction sites, the excavators substituted as cranes in the structural assembly of new workshops. In this work our domestic LK-0.5 excavators displayed especially high qualities.

The war had not yet ended when the swift transference of excavators from the Urals and the eastern rayons to the liberated Donets basin began. The specialized trusts were concentrating about 40 percent of the existing fleet here. The process of clearing the territories of obstructions was begun and restoration work for the future was started.

In tearing down ruined buildings the excavators are used as cranes and as loading machines. An interesting peculiarity of the work of this period is the rejection, in general, of loading by shovels. In order not to waste time in changing the boom, the majority of the machinists changed from crane work to loading by dragline. Experience and the desire to overcome difficulties and to lose no time, showed the possibility of tearing away obstacles by dragline excavators, although this was in contradiction to established practice which accepted only shovels for such work.

From 1946 on, excavators were constantly switched to structural assembly work for restoration and new construction and for the excavation connected with them.

The wartime work of excavators proved a great aid to the country's fuel supply. Output of open-pit coal mining increased 300 percent.

During 3 years of the Stalin Five-Year Plan, great success was achieved both in the field of excavation construction and in the technique of excavator operation.

State of Excavator Production

The war prevented the full execution of the plan for excavator building. While the output ratio of the various projected types of machines was maintained, the total production did not come up to established goals.

The excavator builders of the Soviet Union, during the transition to peacetime construction, began creation of new contemporary types of machinery slowly. As a result of the strenuous work of leading designers in the excavator-building industry, including the colleagues of Rebrov, the chief Satkovsk designer, and excavator experts of the Ural Machine Plant, such as Marenkov, Arvan and others, in the postwar period, and through mastery of machine construction, new excavators were created which surpass in efficiency the best models of foreign make. The postwar models of excavators with dipper capacities of 0.25, 0.5, 1.0, and 3 cu m and two models of continuous-bucket excavators are completely modern models of Union excavator construction.

The state of excavator construction at the present time is apparent from the following data: Model 0.25/5, single-shovel, self-propelled truck, 0.25 cu m dipper capacity, is being turned out steadily. Model D-0.25, single-shovel, caterpillar, 0.25 cu m capacity, test models have been made. Model D-107, single-shovel, caterpillar, Diesel, 0.5 cu m capacity, and Model DPE, single-shovel, electric, 0.75 cu m capacity, are being turned out steadily. Model DG-1/15, single-shovel, caterpillar, 1.0 cu m capacity, an experimental series is being prepared. Model E-3, single-shovel, caterpillar, 3.0 cu m capacity, Model MK-1-M, trench depth 3.5 meters, 45 liter capacity, and Model EM-18, continuous bucket, quarry type, 18 liter capacity, are in steady manufacture.

The distinguishing features of excavators of the postwar period are: increase in specific power /sic/, cutting power, conversion to automatic operation (hydraulic operation), increase in the speeds of working cables and in rotation speeds, decrease in weight, and increase in the number of working cycles.

Study of the designs and test data permit statement at the present time that the D-107 (dipper 0.5 cu m), DG-1/15 (dipper 1.0 cu m), and the E-3 (dipper 3 cu m) excavators rank foremost among the international class.

Types of Excavators

In practice abroad, excavator construction is distinguished by a variety of designs, types, and sizes. In planning our excavators, a minimum was established for variations in standard dimensions, a minimum, moreover, which permits solutions of all problems arising in the field of the mining and construction industries. A minimum of standard dimensions and standardization of equipment permits simplification in the organization of machine construction, utilization of all the advantages of assemble line production, and facility of supplying stock parts.

Construction excavators (0.25, 0.5 and 1.0 cu m) are supplied with universal equipment (straight shovel, dragline, and crane, and for small models, an extra reverse shovel, plane, and hopper). Excavators with a 0.25- and 0.5-cu m bucket must, in addition, be equipped not only with a caterpillar truck but with a self-propelled truck, permitting them to move with a speed of 15-20 km per hour. They must work also as assemble cranes supplied with extra boom extensions to obtain the greatest possible boom length.

Excavators are of service not only in large quarries but also in hydraulic-engineering construction and in excavation work of immense scope.

The development of building-material production and the necessity of reducing the cost of quarry products require a reorganization of strip-pit production technique. The cost of handling the overload is reduced by piling it on an area already mined without the aid of lengthwise of lateral transportation. Strip-pit shovels of the 2- and 3-cu m type can be used for this purpose in order to permit working on the bank with a greater radius of action and a greater lifting height. It is possible to arrange such shovels out of the standard excavators with 2- and 3-cu m buckets by merely changing the length of the working boom and reducing the bucket capacity accordingly.

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Tunnel Excavators

The development in underground construction work requires the production of excavators for such underground work as making pilot cuts and the passage of a complete tunnel section.

Floating Excavators

For underwater extraction of sand and gravel, for cleaning reservoirs and for control of river beds and harbor work, excavators floated on pontoons are used, with single-shovel types for heavy work and bucketchain types for lighter work.

Traveling Draglines

For stripping work on coal and ore layers, for cutting slit and drainage trenches, and for huge hydraulic-engineering construction it is necessary to have special draglines on traveling trucks with a sufficiently high capacity and the greatest possible radius of action. The variety of conditions under which these draglines will be utilized entails the necessity of equipping them with booms of different lengths and reducing the bucket capacity accordingly. The boom length of these draglines will vary within the limits of 25 to 60 meters and the bucket capacity within 4 to 22 cu m.

The expansion of surface coal mining will call for an increase in productivity by conversion to a scheme of strip mining without need of transportation, and by supplying the industry with stripping shovels with a dipper capacity of 15 cu m and with booms of about 30 meters and handles of 19 to 20 meters long. In cases where the dimensions of the slope permit working with shorter booms and handles, the type of machine will remain the same but the bucket capacity will be increased.

ntinuous-Bucket Trenching Excavators

In the postwar period it has been necessary to turn out only two types of trenching excavators: (a) for narrow trenches and for cable trenches of 1.5 meters maximum depth, and (b) for water conduits and shallow drainage systems of 3.5 meters maximum depth.

For excavation of deep (about 6 meters) drainage trenches the MK-II excavator is used. Usually the volume of trench work at construction sites does not meet the seasonal useful capacity of such an excavator. It is sounder to turn out universal, full-swing, ladder excavators, which are capable of making trenches 6 meters deep, and which can, if there is no such work at hand, be used as transverse dredgers.

With the increase of work on small developments and of cutting operations for every type of drainage canal and clearing operation, it is necessary to organize the output of continuous bucket excavators for digging canals with slopes of any given profile.

Cable Tower Units

The cable scrapers, slackline scrapers, and cable tower excavators, which are used in quarry work with wide, cu. surfaces, in shifting material in storehouses, and in hydraulic-engineering work are included in this category.

Low-power cable tower units, when equipped with duo-drum winches and standard

buckets, may have complementary working strength. In the first place it is necessary to organize production of duo-drum winches with the following characteristics: (a) pulling forces of 2.5, 5, 7.5, 10, 15, and 20 tons, and (b) cable speeds of 1.5 and 3 meters per second.

Quality of Machines

Special attention must be paid to the quality of machines. The productivity and, consequently, the cost of production, depend on the machine's speed, and specific speed and specific power.

Excavator buckets should be of maximum capacity; the time of the operating cycle, even on hard ground, should be reduced to a minimum.

The quality of an excavator is determined according to the force it is able to develop in order to make a clean cut in the ground, including the force for hoisting the bucket and boom. It is evident that the necessary increase in the weight of working equipment leads to a decrease in the useful forces. These so-called "forces of a bucket cycle" should not be less than 2.5 tons for an excavator with 0.25-cu m bucket capacity, 3.5 tons for 0.5-cu m capacity, 6.5 tons for 1.0-cu m capacity, 10-12 tons for 2.0-cu m capacity, and 15 tons for 3-cu m capacity.

The lighter the equipment, the more productive the work of an excavator for a given power of its power unit. New excavators should be supplied with a hydraulic or pneumatic control system.

The speed in working operations must be increased in new excavators. Particular attention should be paid to increasing the speeds of rotation, of lifting the dragline bucket, and of adjusting the bucket in loading. The increase in speed will be of special importance for large draglines. Thus, for instance, for draglines with a 60-meter boom the lifting speed should be brought up to about 2.5 meters per second and the adjustment speed to about 1.75 meters per second.

Reduction of the cycle time in excavators produces a sharp increase in their productivity. The individual productivity of machines with buckets of small capacity should be higher than that of heavier machines.

Part of a fleet of construction excavators should be provided with interchangeable equipment such as straight and reversible shovels, draglines, clamshell buckets, a plane, a hopper, a scraper, pile-driver booms, crane equipment, inserts for lengthening the booms in crane work, ramming blocks, and devices for uprooting stumps.

Such a measure makes the construction excavator an all-purpose machine, enlarges the field of its application, and increases the productivity of the fleet.

Interchangeable buckets should provide increased capacity for work on light ground.

The shape of the bucket should be changed. The new excavators should have buckets of rectangular outline, the long side of which is the cutting edge. Such a shape provides great packing space in the bucket and shortens the cutting time. The bucket of the dragline should also be changed. The width of the bucket should be increased at the expense of decreased length. Such a change in shape will increase the packing capacity and will shorten the assembly time.

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Conclusion

Soviet excavator construction, although a comparatively young branch of machine building, is quickly gathering speed to secure the production of machinery necessary in the execution of the most laborious excavation work.

The task set by the Stalin Five-Year Plan for an increase in the production of excavators will be accomplished.

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